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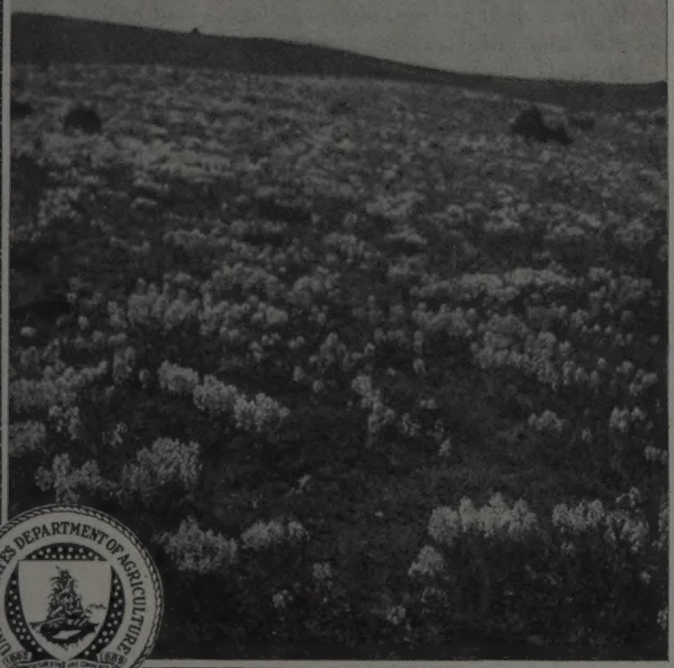
The LOCOWEED DISEASE



20 APR. 1951

LOCOWEEDS are poisonous plants and have caused heavy losses of horses, cattle, and sheep in some parts of the West and Southwest. Seven plants are known definitely to be locoes, a few other related plants are poisonous but do not produce typical locoweed symptoms, and some suspected ones are harmless.

The loco plants described in this bulletin are those which have been studied experimentally according to their distribution, characteristics, and effects on animals. Illustrations of the plants and of poisoned animals accompany the descriptions.

Symptoms of poisoning and proper methods of feeding and treating locoed animals are detailed.

It has been proved, both experimentally and by the practical work of stockmen, that by digging, some of the locoes can be destroyed, that the losses caused by others can be sufficiently reduced to make the effort profitable, and that the cost of the work is not excessive.

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THE LOCOWEED DISEASE

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EXTENT AND CAUSE OF THE DISEASE

THE WORD "LOCO", meaning crazy, is of Spanish origin, and for many years has been applied popularly to a disease common among horses, cattle, and sheep in the Great Plains region of the West. The term is also applied to the various plants, or weeds, that, when eaten by animals, cause the disease. The first printed record of the disease appears to have been that in the monthly report of the Commissioner of Agriculture for October 1873, and the description of the symptoms of locoed animals in that report and in succeeding ones of the United States Department of Agriculture are among the most valuable on record.

Losses of horses, especially in parts of Texas and Arizona, have been very great at times, while in some parts of Montana, Colorado, Nebraska, and Kansas, because of the large number that at times have died of the disease, it was found impossible to run horses freely on the range. The losses of cattle have been heavier, perhaps, in Colorado than in any other State, while the losses of sheep have occurred more frequently in the States farther north, especially in Montana. Serious losses due to other causes have also been thought by stockmen to have resulted from the animals eating locoweeds.

Much investigating, both in the field and in the laboratory, has been done. The results of the earlier studies were very contradictory,

[1] Retired Aug. 31, 1930.
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as a consequence of which many people became convinced that while there was a diseased condition among livestock which doubtless caused very heavy losses, it was due to starvation, parasites, or other causes rather than to any specific poisonous effect produced by plants which the animals had eaten. Most stockmen, however, were convinced that the disease was caused by the eating of certain plants known to them as loco plants.

LOCOWEEDS

A large number of plants have been called locoweeds. Most of them belong to the botanical family Leguminosae, to which belong also the pea, alfalfa, and similar plants.

FIGURE 1.—A small plant of the purple, or woolly, loco, *Astragalus mollissimus*. This plant is found in the shaded territory of the outline map shown in figure 2.

Because many leguminous plants found in the arid and semiarid regions of the West closely resemble one another, there is an unfortunate tendency in some sections to class as locoes many plants which not only are harmless but, on the contrary, furnish good forage. It would be well if the use of the term "locoweed" or "loco" could be confined to those plants that produce the typical loco symptoms described in this bulletin.

Seven plants are definitely known to be locoes, and several others are suspected of having the same characteristics. In addition, there are several related plants that are poisonous for livestock but do not produce the effects that are characteristic of the locoweeds. On the other hand, certain other related plants formerly suspected of being poisonous have been shown to be harmless. Of those plants that produce typical loco effects, the purple loco, white loco, and blue loco are the most important.

THE PURPLE LOCO

The purple loco, or the woolly loco, sometimes known as the Texas or true loco, is the plant that in the past has been considered the most probable cause of loco poisoning. The scientific name is *Astragalus mollissimus*. A small plant is shown in figure 1. In northern Texas, western Kansas, or western Nebraska, when one speaks of loco, this is the plant ordinarily meant. It is also referred to as the stemmed loco, because it has true stems, whereas the white loco is stemless. The pods are two-celled and those of the white loco one-celled.

The purple loco grows in patches on adobe soils, in depressions rather than in elevated situations. It rarely grows in the abundance which is characteristic of some of the other so-called loco plants, but patches of it may cover several acres. Under favorable circumstances a plant may become perhaps a foot in height and occupy a space possibly 2 feet in diameter. The flowers are rather inconspicuous, with very deep-purple corollas, and the pods are hairless, short, thick, two-celled, and, when mature, very dark brown. The leaflets are ovate or elliptical and very densely covered with hairs, from which the plant gets its common name, woolly loco. The long branches of the plant are inclined to lie rather close to the ground.

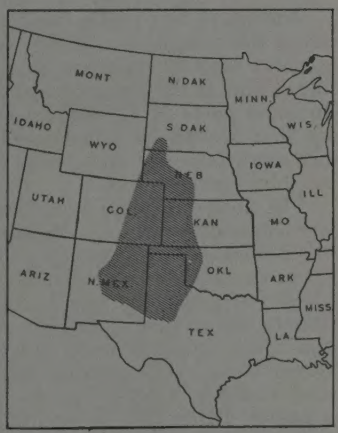

FIGURE 2.—Distribution of the purple loco, *Astragalus mollissimus*. A small plant is shown in figure 1.

The purple loco is found as far north as South Dakota, as far south as Mitchell County, Tex., and Roswell, N. Mex., and as far west as central New Mexico. Its eastern limit may be stated as central Kansas and Nebraska and the western part of Oklahoma (fig. 2). In those areas it grows in varying abundance. It blooms in Colorado about June 1, but farther south, in New Mexico, for instance, blossoms are found early in April.

When the loco investigation was first undertaken by the United States Department of Agriculture in 1905 there was a general belief among stockmen that the purple (woolly) loco was a poisonous plant and a less general belief that the white loco was injurious. The blue loco was generally recognized in the localities where it grew abundantly as a poisonous plant.

Field work carried on during several years has shown clearly that the purple loco is rarely injurious to cattle. Where the purple plant is the only locoweed known, the losses from poisoned stock are limited almost exclusively to horses. Apparently, cattle will not eat the plant readily. The experiments show that under ordinary circumstances most cattle would prefer to starve rather than eat purple loco. Most horses do not take readily to it unless in the first place they are induced to eat it because of short feed. It has been demonstrated that the so-called loco disease of the Plains is not simply

a matter of starvation, as many have supposed, though it is also clear that when other feed is abundant very few horses will eat loco. When, however, because of scarcity of grass, a horse is induced to begin the eating of loco, it is very likely to contract a habit, which leads to continual feeding on the weed, with eventually fatal results.

Under conditions of short feed, the purple loco is eaten late in the winter. Because of its distinctly poisonous effect on horses, results may come more quickly than in the case of the other loco plants, and heavy losses sometimes occur in a short time.

The two species, halfmoon loco, *Astragalus argillophilus*, and Bigbend loco, *A. earlei*, mentioned elsewhere in this bulletin, are very similar in appearance and habit of growth to the purple loco.

THE WHITE LOCO

The white loco plant, *Oxytropis lambertii* (fig. 3), is distinguished from the purple loco by its long, lance-shaped leaflets and by the general habit of the plant, which is erect rather than low and spreading. This is the plant commonly known in Wyoming, Montana, and in some parts of Colorado as "the loco." It has no true stem, and on that account is sometimes called the stemless loco. The leaflets are more tapering and not so hairy as those of the purple loco, and are olive green in color.

The flowers ordinarily are on long stems and in the Plains region are commonly white, although there is considerable variation in their color. Purple flowers are not uncommon. In the mountain regions the white loco ordinarily has very deeply colored flowers, dark shades of violet and purple. It blooms earlier than the purple loco. Plants bloom in Colorado in the latter part of April, and early in the summer the flowers and the pods are found on the still-erect flower stems. The pods are slender and filled with seeds. When dry, they rattle as a person passes through a patch of the plants, making a sound which closely resembles the warning of a rattlesnake. On that account, in some localities, it is known as "rattleweed." Both this plant and the purple loco have extremely long roots, growing down from 3 to 6 feet.

Much more widely distributed than the purple loco, the white loco is found from Saskatchewan and Alberta, and perhaps Yukon, Canada, to Dallas, Tex., and the Chiricahua Mountains in southeastern Arizona; as far east as western Minnesota and western Iowa; and as far west as the Salmon River Mountains, Idaho, Raft River Mountains, Utah, and the San Francisco Mountains, Ariz. (fig. 4). It grows largely on slight elevations and on sandy soil, and in some places in very great abundance. In parts of Colorado, Wyoming, and Montana, at the time of blossoming, large areas are as white as though covered with snow, and in the foothill sections of these States the patches of beautiful flowers are very striking.

Oxytropis lambertii goes under the common names of "white loco" and "rattleweed." In the mountains, however, the term white loco sometimes is applied popularly to another leguminous plant. On account of the color of the flowers in the mountains it is also sometimes known as the pink loco.

Experiments have shown very clearly that horses, cattle, and sheep will eat white loco with great readiness, particularly when grass

FIGURE 3.—White loco, *Oxytropis lambertii*, in bloom. This is much more widely distributed than the other loco plants, as is shown by the shaded portion of figure 4.

is somewhat scarce. Both the white and the purple locoes are green during the winter, when all the grass on the plains is dry and brown. The fact that they are prominent plants, too, induces animals to try them, and because the plants are succulent and somewhat pleasant to the taste, the animals may continue eating. Not only horses but cattle and sheep will eat the white loco, sometimes even with great avidity. Many animals eat it even when grass is abundant, but it is more common for the habit to be contracted during the fall, winter, and spring, when green grass is scarce. Both horses and cattle eat the white loco readily, but perhaps cattle take to it more readily. During the spring, before the grass starts, where the white loco is abundant, practically all animals eat some of it. As the grass becomes more abundant, many of the animals leave the locoweed and eat grass only. These animals, as a rule, do not seem to be injured by the habit. Others, however, acquire an appetite for the plant which is not easily overcome, and will continue to eat it even where there is an abundance of other feed. If allowed access to loco plants such animals eventually become locoed. Some cattle and horses eat locoweeds during a part of the year for several years and suffer no harm. Others acquire a habit which leads them to eat the plant almost exclusively, and die within a few months or, in some cases, even within a few weeks.

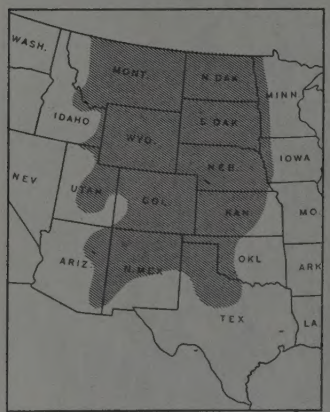

FIGURE 4.—Distribution of the white loco, *Oxytropis lambertii*, in the United States. A plant of this species in bloom is shown in figure 3.

Sheep, also, are poisoned in much the same way as horses and cattle. The effect of the poisoning seems to be peculiarly noticeable on lambs. Frequently they die within 2 weeks of the time they commence to eat the weed, and without any marked loss of flesh.

THE BLUE LOCO OR RATTLEWEED

In western New Mexico, Arizona, southern Utah, and southern Nevada the common loco, most generally known as rattleweed, is the plant known to botanists as *Astragalus diphysus* (fig. 5). It is very different in its appearance from either the white or the purple loco. The leaflets are small, ovate to oblong, and of a deep-green color much like alfalfa. In fact, the plant closely resembles alfalfa in its size, color, and general appearance. The flowers are purple or violet, and on that account it is sometimes called the "blue loco." The pods are inflated, bladderlike, two-celled, and when immature are streaked with purple.

As shown in figure 6, the blue loco is distinctive of the Southwest and has a somewhat restricted range. It is, perhaps, the most common loco of Arizona, western New Mexico, and southern Utah and is

the plant spoken of in that area as "the loco." In many places it grows in great abundance and covers many acres.

The plant probably should be classed as a biennial. It starts growth one summer at such time as conditions are favorable and flowers the following spring. By midsummer the plants have usually matured and dried up. Under favorable conditions many plants may survive throughout the summer following flowering, and in some instances may form a second crop of seeds the same summer or live

FIGURE 5.—Flowers and pods of the blue loco, *Astragalus diphysus*. This plant is very abundant in parts of Arizona, New Mexico, southern Utah, and southern Nevada.

over the second winter, and although rarely thrifty, they may bloom and form some fruit again the second spring.

An abundant crop of blue loco rarely appears in any area oftener than once in 3 years. Each new crop must come from the seeds that have been left in the ground from preceding crops. Although the plant is poisonous to cattle and sheep it is especially injurious to horses.

Experimental work shows that the blue loco is more poisonous to horses than to sheep, and more poisonous to sheep than to cattle.

It is about as poisonous to horses as white loco, more poisonous to sheep, and about half as poisonous to cattle. When dried, it retains its poisonous character, and extensive losses have occurred after the maturity of the plant. The belief that the plant frequently causes cows to abort is well founded.

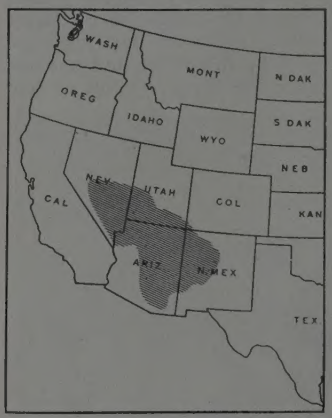

FIGURE 6.—Distribution of the blue loco, *Astragalus diphysus*. The plant, with flowers and pods, is shown in figure 5.

BIGBEND LOCO

Because it occurs in the vicinity of an area in Texas known as the Big Bend region, west of the Pecos River, the plant known to botanists as *Astragalus earlei*, may well be called Bigbend loco. As shown in figure 7, it closely resembles purple loco on the one hand and Bigelow milkvetch on the other. The pods are green in color instead of brown, as are those of the purple loco. In further contrast with the pods of the latter species, which are smooth, the pods of Bigbend loco are somewhat hairy or pubescent but much less so than those of Bigelow milkvetch. (See p. 21.) The flowers are almost always purplish, the stems, especially those of the older plants, often lie somewhat close to the ground. Under favorable conditions many of the plants may be 2 feet or more across. Although the average plant probably produces less than 50 flowering and fruiting stems, some of the more thrifty ones may have upward of eight times that number. Such plants naturally produce an enormous number of seeds.

Although Bigbend loco, like the purple loco and the halfmoon loco, are generally classed as perennials, few of the plants live more than one growing season, and usually one plant forms only a single crop of seed. As a rule plants start from seed in the late summer or fall, live over winter, and the following spring bloom and produce fruit. Because of climatic conditions or other causes most of the plants die within a few weeks after the development of the fruit.

Areas on which this plant is abundant 1 year may be almost devoid of it the following year and for 2 or 3 succeeding years. On the other hand, areas on which it is absent 1 year may be virtually covered with it the next. The reasons for these changes are not entirely known. It seems apparent, however, that the seeds sometimes lie in the ground for several years and germinate when conditions are favorable. It is evident that the new growth is from seed and that the perpetuation of the species is dependent on the seed. The conditions leading to, or necessary for germination, are unknown.

F. P. Mathews, who is in charge of a cooperative study of locoweeds and other stock-poisoning plants, for the Texas Agricultural Experiment Station and the United States Department of Agriculture, at Alpine, Tex., has shown Bigbend loco to be toxic for cattle, horses, sheep, and goats, and to produce typical loco symptoms in

these animals. He has also shown that pregnant cows feeding on this species of loco are very likely to abort and that the normal sexual reactions in both bulls and cows are modified or suppressed as a result of their feeding on the plant.

FIGURE 7.—Bigbend loco, *Astragalus earlei*. It is the most abundant loco of the portion of Texas west of the Pecos River.

In the extreme western part of Texas and southern New Mexico there is some overlapping of the ranges on which Bigbend loco and Bigelow milkvetch grow. In some places both occur in the same locality.

THE HALFMOON LOCO

A plant which in its general appearance resembles both the purple loco and Bigbend loco, and is called by botanists *Astragalus argillophilus*, is found on a restricted portion of the High Plains and Edwards Plateau of Texas, east of the Pecos River. Like the purple

loco and Bigbend loco, the stems and leaves often lie more or less close to the ground and are hairy. Unlike these two species the flowers are ochroleucous or yellowish in color instead of purple. The pods are greenish, similar in shape to those of the two locoes named, and somewhat hairy. They resemble the pods of Bigbend loco in color but are much less hairy. In both hairiness and color they differ from the pods of the purple loco, which are without hairs and brownish in color. In areas where halfmoon loco grows, an occasional plant is found with purplish flowers, and in areas where Bigbend loco is present in abundance, a very few plants with yellowish flowers are sometimes found. These would appear to suggest a close relationship

FIGURE 8.—Two small plants of halfmoon loco, *Astragalus argillophilus*, showing the shape of the leaves and flowers. Its resemblance to purple loco and Bigbend loco is apparent. The flowers are yellowish.

between the two forms although the areas of distribution do not strictly overlap.

In habits of growth, as in methods of dispersal and perpetuation of species, halfmoon loco closely resembles Bigbend loco. It has been called a perennial and in certain characteristics this is justified. It is probable that the length of time a given plant lives is dependent on climatic conditions. In this respect the species probably behaves much like the closely related Bigbend loco. The general appearance of two young plants is shown in figure 8.

Although halfmoon loco is abundant in many places within its range and is about as poisonous as Bigbend loco, the losses of livestock caused by it are not, as a rule, heavy.

WOOTON LOCO

Wooton loco, *Astragalus wootoni* (fig. 9), is a common annual loco of southern New Mexico, eastern Arizona, and southwestern Texas, and extends southward into Mexico. Other common names applied

locally to this species are garbancillo and rattleweed. However, these names are applied also to various other locoes and so are not distinctive. The pods of Wooton loco are very large, one-celled, and much inflated. The leaves are narrow and their lower side is often covered with a whitish bloom. The plants are spreading, and vigorous ones in moist soil are often found in cushions 3 or 4 feet across, reaching a height of 1 foot. *A. wootoni* and another species having much the same range, *A. allochrous*, are very similar in appearance. *A. wootoni* is found more commonly in firm adobe or sand loam soils, while *A. allochrous* is more adapted to sandy draws and occurs at higher altitude than *A. wootoni*. Both species vary greatly in abundance in different years.

FIGURE 9.—Leaves and pods of Wooton loco, *Astragalus wootoni*.

Of the two plants, *Astragalus allochrous* has the larger flowers and pods. It is probable that *A. allochrous* has poisonous qualities similar to those of Wooton loco. Wooton loco is poisonous to all classes of livestock. In some sections it is regarded as one of the most dangerous of the locoes—an opinion that appears to be supported by experimental evidence.

Many stockmen believe that the dry tops, remaining after the plants mature and die, retain their poisonous qualities for an indefinite period and that losses are caused by animals eating them. There appears to be no experimental evidence to confirm or refute this idea.

THE SHEEP LOCO

Sheep loco, sometimes called purple-top, *Astragalus nothoxys* (fig. 10), is found in southeastern Arizona and adjoining Mexico and New Mexico. This plant lies nearly prostrate, often covering 2 feet in

diameter. The flowers are white-tipped or spotted with violet. The pods are narrow and nearly two-celled (partition not quite complete), sharp pointed, and an inch in length. The leaflets are in about six pairs, oval, notched, and nearly smooth. It is abundant in the foothills (from 5,000 to 6,000 feet in altitude) in the Santa Catalina, Santa Rita, Huachuca, and Chiricahua Mountains, and as far north as Mount Graham. Just why this plant should be called sheep

FIGURE 10.—Leaves, flowers, and pods of sheep loco, *Astragalus nothoxys*.

loco is not known, for it grows especially in a country where sheep are not pastured and is thought to cause heavy losses among cattle. In the experimental feedings of sheep and cattle, it was found to be as poisonous as the common blue locoweed.

THURBER LOCO

Thurber loco, *Astragalus thurberi* (fig. 11), is another typical southwestern loco with a range very similar to that of the sheep loco but extending somewhat farther into New Mexico. It is a close

relative of Wooton loco and is sometimes found growing in the same localities. Thurber loco also makes a large mat on the ground. It is easily distinguished from the other species by the shape of its pods, which are round and inflated, resembling large peas. Growing in pairs on long stems, they are rather conspicuous.

FIGURE 11.—Thurber loco, *Astragalus thurberi*. Note the small, pealike pods.

This species has been considered as especially poisonous to horses but has been fed experimentally to cattle and has been found not to differ, materially, in toxicity from *Astragalus wootoni*.

OTHER LOCOES

Besides those that have been described there are several that are thought to be locoes in the sense in which the term is used in this

bulletin. As the evidence concerning their poisonous qualities is not based on experimental studies, they have not been included.

RELATED PLANTS, POISONOUS, BUT NOT LOCOES

THE TWO-GROOVE POISONVETCH

Two-groove poisonvetch, *Astragalus bisulcatus* (fig. 12), ranges from northern New Mexico and the Oklahoma Panhandle through central Colorado, Wyoming, western South Dakota, North Dakota,

FIGURE 12.—Two-groove poisonvetch, *Astragalus bisulcatus*. Note the drooping, two-grooved pods.

and Montana into Manitoba, Saskatchewan, and Alberta. It is an erect, tall plant, growing to a height of 2 feet, with purple flowers. The pods are two-grooved on the front and are hairy. The plant is coarse in appearance and in some areas has an offensive odor.

In the earlier reports from the Wyoming Agricultural Experiment Station, the two-groove poisonvetch, or milkvetch, was said to pro-

duce symptoms of loco poisoning. Its principal effect, however, as now reported by that station, appears to be of a more acute nature, or to develop suddenly after prolonged feeding on the plant. It has been shown that the two-groove poisonvetch has a remarkable power of taking up selenium from the soil and concentrating the mineral in its own tissues. This appears to account in part, but not entirely, for its poisonous qualities. In some instances plants growing on a soil containing 0.8 to 4.0 parts per million of selenium have themselves contained from 3,030 to 4,300 parts of this mineral. This in itself is sufficient to render the plants very poisonous to animals.

PALLISER POISONVETCH

The Canadian species, Palliser poisonvetch, *Astragalus palliseri* (fig. 13), sometimes known as *A. campestris*, extends south a short

FIGURE 13.—Palliser poisonvetch, *Astragalus palliseri*. Reported in British Columbia to be poisonous.

distance in the Cascade Mountains and to Yellowstone Park in the Rocky Mountains. In Canada it is sometimes called "timber loco." Its stems are extending, sparingly hairy, about 1 foot in height. The leaflets, in from four to nine pairs, are narrow and smooth above. The flowers are purple and the pods linear, one-half inch long, smooth and round in section.

The losses in the United States occasioned by this plant are probably small. It is mentioned here because of the losses in parts of British Columbia reported by Bruce, and the fact that its range extends into the States of Washington, Idaho, and Montana.

The plant is poisonous to all classes of livestock, but lactating females are said to be the most susceptible. The effects are very different from those produced by the true locoweeds. Incoordination, difficult respiration accompanied by wheezing, whistling, or roaring, and loss of voice in cattle and sheep are said to be the characteristic symptoms.

FIGURE 14.—Stems, leaves, and pods of timber poisonvetch, *Astragalus hylophilus*.

THE TIMBER POISONVETCH

The timber poisonvetch, *Astragalus hylophilus*, a plant closely related to *A. palliseri*, grows in abundance in areas in northern

Utah, southwestern Wyoming, and northwestern Colorado. This appears to be the same plant as that called both *A. campestris* and *A. hypophyllus* by the Wyoming Agricultural Experiment Station, and *A. campestris* by some other observers. The difference in names merely indicates the difficulties in determining some of these closely related plants. It is usually found at altitudes above 7,000 feet and in places grows vigorously in aspen groves, but may occur in dense stands in sagebrush areas. The general appearance of the leaves, stems, and pods is shown in figure 14. The stems are slender, usually erect, about 7 inches tall, and slightly hairy. The flowers are small

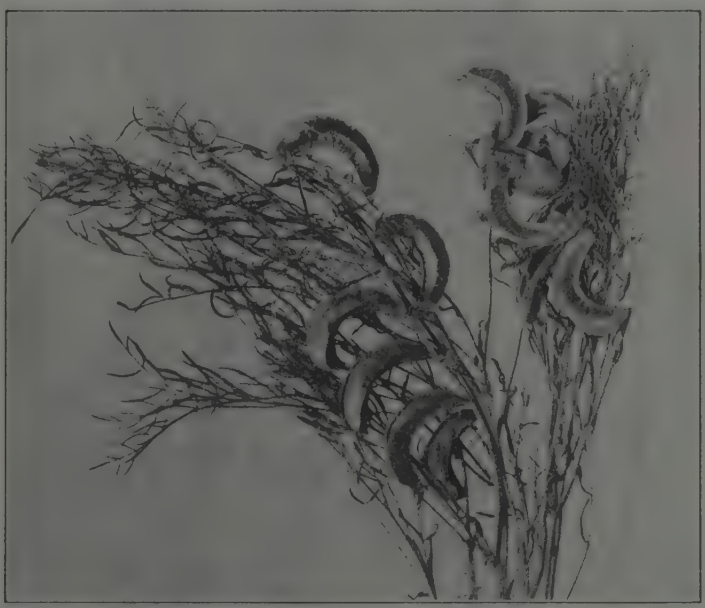

FIGURE 15.—Four-wing poisonvetch, *Astragalus tetrapterus*. The form of the pod is characteristic and found in no other *Astragalus*.

and white and tinged with purple; the pods are long and pointed. It usually flowers about the first of July and matures in August.

The plant appears to be most poisonous when green and to lose much of its injurious qualities when dry. Cattle and sheep are affected by it. In some instances acute poisoning occurs. It is said also by the Wyoming Experiment Station to produce chronic emaciation, incoordination, and diarrhea. In acute poisoning, labored respiration is pronounced.

THE FOUR-WING POISONVETCH

Four-wing poisonvetch, *Astragalus tetrapterus* (fig. 15), is, as far as is known, confined entirely to southwestern Utah and eastern Nevada. The plant is nearly glabrous, and the flowers are white or

light purple. The pods are 1 inch in length, one-celled, woody, and have four distinct wings, a form which distinguishes it from the other Astragali.

This *Astragalus* is a distinctly poisonous plant but can hardly be called a locoweed, as the symptoms produced by it are not considered

FIGURE 16.—Straight-stem poisonvetch, *Astragalus sabulosus*. Reported in New Mexico to be poisonous.

typical of locoism. The principal losses have been in cattle and sheep, although losses of horses have been suspected. The symptoms in the cattle as seen on the range are weakness, with a peculiar weaving movement of the hind legs in walking. In corral feedings, both cattle and sheep have been poisoned.

THE STRAIGHT-STEM POISONVETCH

The straight-stem poisonvetch, *Astragalus sabulosus*, sometimes known as *A. praelongus* (fig. 16), grows in southwestern Colorado and southern Utah and in the desert sections of eastern California, southeastern Nevada, and south to central New Mexico and Arizona. It is a large, smooth, erect plant, readily recognized by its oval, short-pointed, inch-long, woody, single-celled pods. The leaflets, in from 7 to 10 pairs, are oval and often notched at the end. The flowers are yellowish and in thick clusters.

Reports of poisoning due to this plant have been received only from Magdalena, N. Mex., where it has been found to be very poisonous. In feeding experiments with sheep, acute symptoms of poisoning were produced.

SUSPECTED PLANTS WHICH ARE NOT LOCOES

A great many leguminous plants, suspected of being locoes, are either harmless or, as in some cases, are valuable as forage crops. Their number is so great that it would be impracticable even to list them, but two are so widespread that it is worth-while to give a brief description to convince the stockman that he has no reason to fear them.

THE CLOVER MILKVETCH

The plant, clover milkvetch, *Astragalus striatus* (fig. 17), is found abundantly in some sections, sometimes associated with the white loco. It occurs most commonly in the foothills of the eastern slope of the Rocky Mountains, but sometimes extends into the Plains region. The leaflets resemble, in form, those of the white loco, but are of a deep-green color instead of olive green. The plant is distinguished too by its rather stout stems and the purplish and not very conspicuous flowers, which are in compact heads resembling those of clover. Frequently it is found growing in fairly thick masses in shaded places, like the edges of aspen groves, whereas the white loco grows better in the open. Though *A. striatus* is considered by many as a locoweed, careful experiments have proved its harmless character, and probably it should be classed as one of the desirable forage plants.

DRUMMOND MILKVETCH

The plant shown in figure 18, Drummond milkvetch, *Astragalus drummondii*, is large and rather coarse and occurs from Utah, northern New Mexico, and Nebraska to the Red Deer Hills of northern Alberta. It has yellowish-white flowers, and both the flowers and pods droop from their attachments, and by this habit the plant is readily recognized.

This plant has nearly the same range as the two-groove poisonvetch and in general appearance closely resembles that species. Both are coarse plants, and in both the pods droop in a characteristic way. But the flowers of the two-groove poisonvetch are purple, and the pods, as the name indicates, are two-grooved, while the flowers of *Astragalus drummondii* are yellowish white and the pods are one-grooved. It is not a locoweed, and its coarseness renders it unattractive to grazing animals.

FIGURE 17.—Clover milkvetch, *Astragalus striatus*. This plant resembles the locoweeds, but it is not poisonous, though often suspected of being so. It is widely distributed on the eastern slope of the mountains and in the Great Plains region.

BIGELOW MILKVETCH

Bigelow milkvetch, *Astragalus bigelovii* (fig. 19), grows from the Davis Mountains, Tex., and Roswell, N. Mex., northwest to Grand

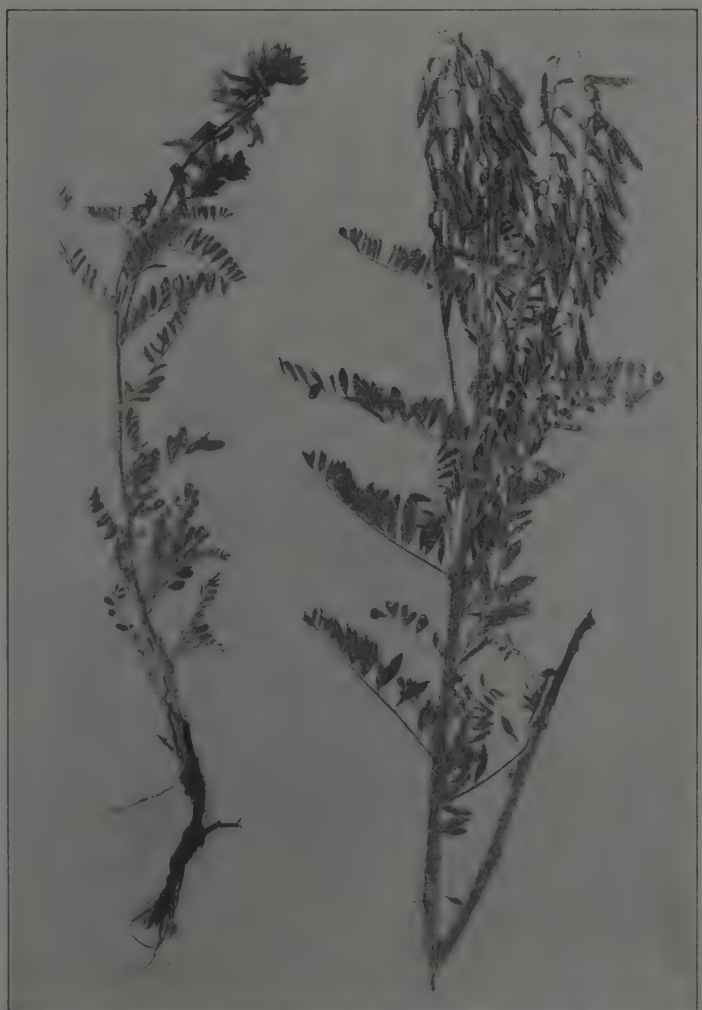

FIGURE 18.—Drummond milkvetch, *Astragalus drummondii*. This very common plant is frequently called a loco, but it is not poisonous. It closely resembles, in form, the two-groove poisonvetch, but its flowers are yellowish white and its pods are one-grooved.

Canyon, Ariz., and southward into Mexico. In its general characteristics and growth habits the plant resembles the purple loco, *A. mollissimus*, as well as Bigbend and halfmoon locoes, and its

leaves resemble those of the three species in form, color, and the fact that they are covered with hair. Because of the resemblance it is sometimes known as Texas loco or woolly loco. Besides being a much larger and coarser plant, it can be distinguished from the three related species by its pods, which are shorter and are densely woolly, whereas those of the purple loco are smooth and dark brown

FIGURE 19.—Bigelow milkvetch, *Astragalus bigelovii*. This plant, growing in Texas, New Mexico, and Arizona, resembles the purple loco but is much larger and coarser.

and those of Bigbend and halfmoon locoes are much less hairy than those of Bigelow milkvetch. It has from 7 to 12 pairs of leaflets, whereas the purple loco has from 11 to 14 pairs. In all of these species the pods are two-celled. The areas where Bigelow milkvetch and Bigbend loco grow overlap to some extent in western Texas.

The purple loco, Bighend, and halfmoon locoes produce in animals the typical symptoms which have given the disease its name. Although Bigelow milkvetch is by some considered to be a loco, the air-dried plant has been fed to cattle in very large quantities without producing loco symptoms or otherwise materially injuring the animals. One heifer was fed with dry material the equivalent of more than three times its weight of the green plant without any ill effects being produced.

SYMPTOMS OF LOCO POISONING

IN HORSES

The first symptom of loco poisoning in horses is often a change in the general condition of the animal. If high-spirited, the animal becomes somewhat dull. Following this, irregularities in its gait and

FIGURE 20.—A typical locoed horse. Note the abnormal growth of tail and mane, which is characteristic of the disease.

in its mode of eating appear. The irregularities in the gait may be due partly to weakness and simulate a paralytic affection. The horse drags its feet more or less; this is particularly noticeable in the hind legs. Associated with this paralytic condition is an apparent loss of normal muscular control. In stepping over a slight obstruction, the horse lifts its feet unnecessarily high, or, in going over a rut in the road, it may leap as if jumping over a ditch.

As the disease progresses, the animal becomes solitary in its habit, and seems to lose very largely its nervous sensibility. If a person approaches a badly locoed horse, it does not notice him until he is within a few feet, when it may suddenly rear and perhaps fall over backward. When it drinks or eats, there is a peculiar, stiff motion of the jaws, showing a lack of control of the muscles. If a locoed horse is used either in riding or driving, the lack of muscular control may make it extremely dangerous, as such a horse shies violently at imaginary objects, cannot readily be led or backed, and if started in motion is inclined to go in an automatic fashion at the same gait until stopped by some obstruction. In the later stages of

the disease, the animal loses flesh, its coat becomes rough, and eventually it ceases to eat and dies. Figure 20 shows a typical locoed horse.

IN CATTLE

The symptoms of locoed cattle are similar to those of locoed horses, the differences being only such as would be expected from the different character of the nervous organization of the animals. There is the same lack of muscular control, and while a steer is not likely to fall over backward, it will start and tremble and perhaps rear and jump backward when suddenly alarmed. The head of a badly locoed steer shakes violently, particularly after the steer has become heated. Ordinarily a locoed steer is dull, but under some

FIGURE 21.—A typical locoed steer. Locoed cattle have rough coats, staring eyes, and, in the last stage, eat and drink very little.

conditions it may become frantic and run into obstructions in an utterly unreasonable way. It is commonly said by stockmen that it is impossible to drive a locoed steer because it is just as likely to run into the driver as in the opposite direction.

Locoed cattle gradually lose flesh, have staring eyes, rough coats, go to water less and less frequently, and eventually die of starvation. A typical locoed steer is shown in figure 21.

Loco is generally supposed to predispose to abortion, and in feeding Bigbend loco experimentally, F. P. Mathews, of the Texas Agricultural Experiment Station, confirmed this opinion. In some instances serious losses from this source have apparently occurred.

IN SHEEP

The symptoms of poisoning in sheep are not so marked as those in horses and cattle. The lack of muscular control is not so noticeable but still exists. Locoed sheep show, perhaps, more clearly the

weakness which goes with the disease, as they stumble and fall and rise again only with great difficulty.

Figure 22 shows a typical locoed sheep.

There is considerable difference in the readiness with which various breeds of animals eat locoweeds. It is a matter of common observation on the plains that the so-called native breeds are very much less likely to be locoed than are imported animals. This, of course, is to be expected from the fact that the imported animals are not familiar with the plants, and in many cases do not have the quality of "rustling", so that they are inclined to eat the feed which is most

FIGURE 22.—A typical locoed sheep shortly before death.

easily obtained rather than seek more suitable plants. Generally speaking, the finer breeds of cattle and horses are more likely to be locoed than the poorer breeds. The same thing is true of sheep, it being particularly noticeable that those with black faces are much more apt to be locoed than are the Merinos.

IN GOATS

In his work with Bigbend loco and Wooton loco, Mathews produced symptoms in goats that were very different from those seen in sheep. In the goats the first evidence of any effect was a weakness in the hind legs that was particularly conspicuous when the animals were startled. At first this weakness was transitory. As the effects became more pronounced a definite paralysis in the hind legs de-

veloped and the forelegs eventually became involved. In some advanced cases the hindquarters rested on the ground, and the head was thrown back in a position resembling that in opisthotonos. Shaking of the head and twitching of the eyeball were also observed. The cerebral depression seen in sheep was not observed in the goats.

POST-MORTEM APPEARANCE

Post-mortem examinations of locoed animals do not always show clearly marked evidence of the progress of the disease. Since in all cases of fatal poisoning the locoed animals die of starvation, they are profoundly anemic, as would be expected, and as a result accumulations of coagulated serum in a gelatinous form are found in various parts of the body.

In his experimental work with white loco, *Oxytropis lambertii*, C. Dwight Marsh, formerly in charge of the investigations of stock-poisoning plants for the United States Bureau of Animal Industry, found in locoed animals ulcerations of the wall of the true stomach and the intestines and an excessive accumulation of serum in the spinal canal. Although Mathews, in working with Bigbend loco, observed a more or less general mild edema, or serous infiltration, and in some cases ulcerations of the stomach of poisoned animals, he did not consider the lesions particularly characteristic of the loco disease. Mathews did, however, observe in pregnant cows an edematous condition of the wall of the uterus and the fetal membranes. In some instances the fetal membranes were between 2 and 3 inches thick and of a gelatinous consistence. This condition was associated with abortion by the pregnant cows.

TREATMENT OF LOCOED ANIMALS

In common with other types of plant poisoning and practically all animal diseases, reliance should be placed on attempts to prevent loco poisoning rather than on any so-called remedies. Complete prevention in areas badly infested with loco, or in seasons when the plants are abundant, is of course virtually impossible. Partial prevention, or keeping the number of locoed animals from becoming excessive and saving many of those that do become affected, is entirely possible and economical. Before any preventive or remedial measures can be applied one must know something about the plants involved, their habits of growth, palatability for the animals and the conditions under which they are most likely to be eaten. As the various species or kinds of loco vary greatly in their characteristics and as in some areas losses due to other causes have been attributed to loco, no one plan will fit all loco areas.

As a preventive measure, it is of first importance that animals and grazing areas should be so managed that palatable and wholesome forage is available at all times and in sufficient quantity and variety. Animals rarely start eating loco when these conditions exist. As this, in the areas where loco occurs, is not always practical or possible, even when supplementary feed is furnished, a number of animals are very likely to be locoed whenever the loco plants are abundant.

Loco poisoning usually develops more or less slowly, depending on how much of the plant is being eaten. If, before the disease has

progressed too far, the animals are prevented from eating more loco and are given nutritious, wholesome feed in its place, most of them will improve in condition. For this purpose alfalfa, especially green alfalfa pasture, cottonseed cake, and grain, or a combination of these, are excellent. As the most important consideration is one of economics, the feed to be used will of course depend on the kind available and the cost.

There is no specific treatment for loco poisoning; therefore, any treatment that is attempted should have for its object the building up or improvement in the physical condition of the affected animals. Nature usually takes care of this process fairly well, especially where nutritious feeds are available. If, in addition to nutritious feed, some general stimulant can be used, the process of recovery can be hastened to some extent; that is, if in administering the stimulants the animals are not excited or caused to exert themselves unnecessarily. Attempting to treat wild or half-wild animals may do more harm than good. It should be remembered also that nervous effects accompany loco poisoning. These do not readily yield to treatment and, especially in horses, they may be more or less permanent. Locoed horses rarely, if ever, fully recover from the effects on the nervous system.

Under experimental conditions the administration of certain remedial substances has been found beneficial. With horses the best results have been obtained by giving 4 to 6 drams of Fowler's solution daily, either in the drinking water or with grain feed. With cattle daily hypodermic injections of three-twentieths or four-twentieths of a grain of strychnine have hastened recovery. In the experimental study less beneficial results were obtained when sodium cacodylate in 6-grain doses, given hypodermically, was used. With both horses and cattle, treatments were continued daily for about a month, which, of course, is not practical under range or large-pasture conditions. The experimental animals were accustomed to being handled and were not excited or disturbed by the treatment.

It should be emphasized that loco poisoning is a chronic condition that develops slowly, often after weeks or months of grazing on the specific plants that cause it, and that, therefore, rapid recovery cannot be expected.

POISONOUS SUBSTANCES IN SPECIES OF ASTRAGALUS

Many of the earlier investigators made unsuccessful attempts to determine the nature of the poisonous substance in locoes. One thought that the peculiar effects were due to barium, but this opinion was later shown to be incorrect. More recently a definite and very poisonous compound has been obtained from two or more species. This when fed to animals over a period of time will produce typical loco symptoms. Although it is now known that the peculiar effects of loco are due to a definite substance which is contained in the plants, much remains to be learned about it. It is known, however, that this substance does not contain barium. In view of certain trends in the investigation of stock-poisoning plants, it is also of interest to know that this substance does not contain selenium.

Little is known about the toxic principles contained in most of the species of *Astragalus* that are poisonous but do not produce loco

symptoms. It has been shown, however, that some of these plants have a remarkable power of taking up selenium from the soil and concentrating it in their own tissues. This is true of the two-grooved poisonvetch and of three species that have been identified as *A. flavus*, *A. grayi* and *A. pectinatus*. There appears to be no evidence that under natural conditions *A. grayi* and *A. pectinatus* ever poison animals. Field evidence indicates that the plant provisionally determined as *A. flavus* does occasionally poison animals. A few preliminary experimental tests made with it indicate that its poisonous qualities may be due entirely to the selenium it contains.

GROWTH HABITS OF LOCOES

From the standpoint of use and of the attempts at clearing the pastures and ranges of loco, a knowledge of the growth, habits, methods of propagation, and length of life of the species of plants infesting the areas is important. In general, plants are divided into annuals, biennials, and perennials, depending on whether they live 1, 2, or more years. This division is of value, but it does not tell all we need to know. In fact, as they have been applied to different species of loco, the terms have often been more misleading than helpful. It is probable that the length of time some of the species live is dependent on local conditions. Thus a plant that has the appearance of a perennial may in some areas act as a biennial, or even a winter annual. This is true of Bigbend loco as it grows in the trans-Pecos country in western Texas and of the halfmoon loco in the High Plains section of Texas, east of the Pecos River. Both species, as well as the two plants which they closely resemble, the purple loco and Bigelow milkvetch usually have been classed as perennials. Although our knowledge in regard to the habits of growth and methods by which the species are perpetuated is fragmentary, there are certain facts that should be pointed out.

The white loco is a true perennial. It has a large, deep-growing root that lives from year to year and under favorable conditions may flower and form fruit for several successive years. It produces an abundance of seed which, at least under experimental conditions, may retain its ability to germinate for several years. Just how much reseeding or reproduction from seed may occur under natural conditions is unknown. As a very large proportion of the plants in experimental plots have been killed by a single grubbing and the areas have been kept free of loco by very little work in succeeding years, it is very probable that comparatively little reproduction from this source occurs with this species. As no new growth takes place when, in grubbing, the plants are cut off 2 or 3 inches below the crown, it is evident that adventitious buds do not form on the roots below that point.

In respect to the length of life of individual plants and the reproduction from seed, at least in places where they have been kept under observation, Bigbend and the blue loco differ greatly from the white loco. As observed in western Texas, Bigbend loco, and, as seen in Utah and Arizona, the blue loco, act more like winter annuals or biennials. Bigbend loco usually starts growth from the seed in the fall and, when conditions are favorable, during the winter and early spring. As soon thereafter as weather conditions

make it possible, the plants grow rapidly and bloom early. Frequently they are in full bloom in March and early April. Thrifty plants are usually heavily loaded with fruit, which may mature in April. After fruiting, the plants, one after another, dry up and die. Some may retain a few live leaves until fall, but in the average year most, if not all, that have produced fruit die before the end of the growing season during which they have bloomed. An examination of the roots of such plants shows them to be entirely dead. Some thrifty plants may be 2 feet or more in diameter and produce 500 or more flowering and fruiting stems and innumerable seed. Pods and seed may be found in great abundance around such plants after the stems and leaves have entirely dried up and the roots have died. The fact that areas where many plants have flourished and formed seed one year may be almost free of plants the next, and for 2 or 3 years thereafter, indicates that plants that have matured normally rarely, if ever, live over a winter after fruiting. In some very stony areas, where it is impossible to cut the root off below the surface of the ground, control has been attempted by cutting them off, at or just above the crown, two or three times each season. If conditions are favorable, many such plants start growth again almost immediately and may, in some instances, persist over winter. Areas practically devoid of loco for one or more seasons may suddenly be overrun with the plants, which indicates clearly that when conditions are favorable the seed of this species may germinate in great abundance.

As a rule, plants of Bigbend loco and its close relative the halfmoon loco, when cut off 2 to 4 inches below ground, do not put out new growth. There have been many conspicuous exceptions to this rule. In looking over areas where the halfmoon loco had been grubbed many plants were found that obviously had been cut off 4 inches or more below ground but had formed buds at the cut surface and started new growth. In some grubbed-over areas plants of this species have been found that had been cut off twice, once 4 to 5 inches below ground, and the second time about 2 inches below the surface, and each time had started to grow again. Such a plant is shown in figure 23. There is evidence that such plants may live for more than one or even two seasons, or until they have formed fruit. Obviously, such species, especially of plants whose seed may survive in the ground for several years and then germinate in great number, are less easily exterminated than those not so well adapted to unfavorable conditions.

Blue loco is similar to Bigbend and the halfmoon locoes in some respects. New plants start growth, obviously from seed, during the spring and summer months, or from March until October, and perhaps in some cases later. They rarely, if ever, blossom the first season. In March or early spring following the summer when the seed germinated the plants bloom, often forming veritable flower gardens. After fruit is formed, if the ground becomes dry, most of the plants die. A few may survive, and if moisture is plentiful, later in the season they may bloom again and form a second crop of seed the same season. Under favorable conditions a few, perhaps 25 percent, of the plants will live over a second winter and attempt to bloom and form fruit again. Apparently such plants, although

they may put out a few flowering stalks, are vigorous only in rare instances. Those kept under observation have died in the early part of the second summer in which they attempted to produce seed.

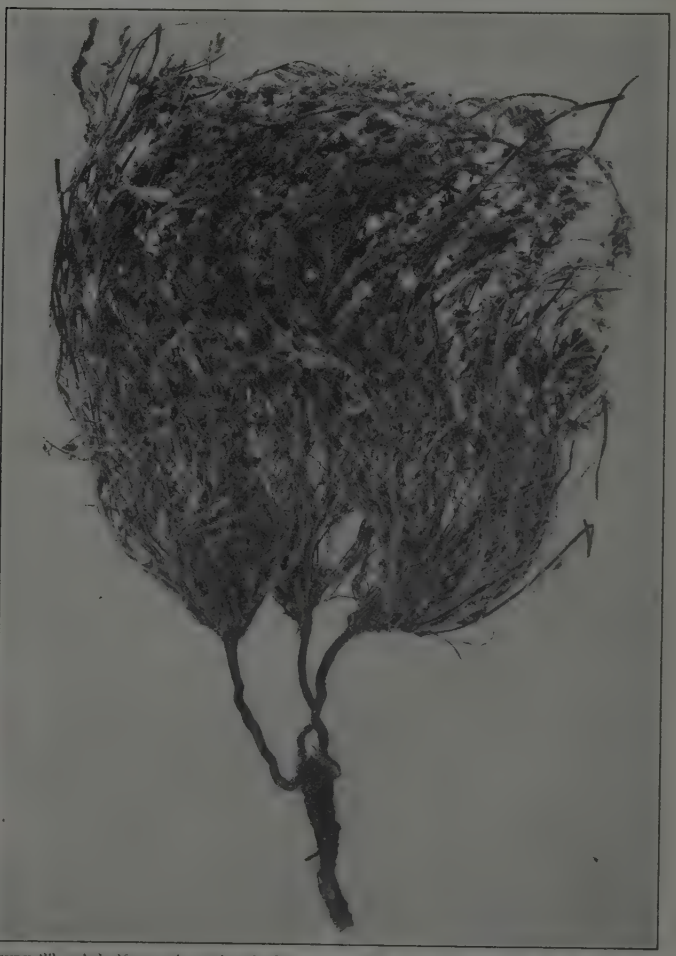

FIGURE 23.—A halfmoon loco that had been cut off twice in grubbing, once about 6 inches below the crown and a second time about 2 inches below the new crown. Each time it had started growing again.

Although such plants, taken as a group, are not typical of either of the other groups, they can hardly be called perennials.

Wooton loco and the closely related *Astragalus allochrous* are, in some publications, spoken of as perennial. In a considerable por-

tion of the areas in which it grows, Wooton loco certainly is not perennial. In some places it appears to be strictly an annual. In some places and under some conditions it may be a winter annual, but even this is doubtful. As a rule, plants of these species start from seed each year, develop rapidly, and mature early in the summer. Sometimes the dry plants may remain standing for 1 or 2 years, but after fruiting they die and do not start growth again.

DESTRUCTION OF LOCOES

The complete destruction or eradication of locoes which grow in great abundance over vast areas, especially if the land is of little value, is, of course, economically impracticable if not impossible. On the contrary, clearing poisonous plants from pastures or areas of limited size, or a sufficient reduction in their abundance to make the areas safe for pasture, is often feasible. This is especially true of some species of loco. With other species attempts at eradication are less liable to succeed. Much depends on the habits of growth of the plants and the conditions under which they grow. As the several locoes vary greatly in many ways, method of clearing fields of one may not be as successful with other kinds. Because some species, such as Bigbend and the blue locoes, usually appear in abundance in a given area only once in several years erroneous conclusions regarding attempts at eradication in these areas may be drawn unless the areas are kept under close observation for several years and compared with other areas where no such attempts have been made.

The method most often used in attempting to clear loco from pastures has been grubbing. Various types of tools have been used. The one that appears to have been the most successful has been one modeled after the ordinary grub hoe, only with a much narrower blade. For this purpose a blade about 2 to 3 inches in width has been used successfully. Some men have had such tools made by narrowing the blade of an ordinary grub hoe; others, by widening out and flattening one point of an ordinary pick. Still others, preferring a lighter tool, have had blades constructed of old pieces of broken automobile springs.

In his experimental work with white loco (a perennial), Marsh obtained excellent results by grubbing. He found that areas could be successfully and economically cleared of this plant by this method, provided the roots were cut off 2 or 3 inches below ground. In his experience more or less reseeding occurred, but the cost of eradicating the new plants was not great. To be successful, even with white loco, grubbing should be followed up and all reseeding prevented. This requires that new plants that come up should be destroyed before they form seed.

In some areas where Bigbend loco, halfmoon loco, and blue loco grow, grubbing has been practiced for more than 30 years. Although the results have been less satisfactory than with the white loco, many ranchers have considered them profitable. Some men, who have grubbed Bigbend loco consistently for many years, believe they have materially reduced its abundance in their pastures. Others feel confident that the operations have resulted in the saving of a sufficient

number of animals to make the work profitable. If, as appears to be the case, this is true over a series of years the practice is well worth while and should be encouraged.

With species, such as Bigbend, halfmoon, and blue locoes, that reproduce largely from seed, the grubbing, to be effective, must be done each year before the seed is formed. When dealing with plants that are capable of producing in great abundance seeds that may lie in the soil several years before germinating, the problem of eradication becomes more difficult, and preventing the plants from going to seed is of greater importance.